



SEVERING TOOLS (ST) FIELD ASSEMBLY and ARMING

March 31, 2005

1.0 DESCRIPTION

- 1.1 Titan Severing Tools (ST) are colliding tools, making use of EBW (Exploding Bridge Wire) Detonators, initiated by the ECOSSE fire set (Fig. 2). For reference, a wiring diagram is included (Fig. 1).
- 1.2 The ST is a "user friendly" design, **pre-wired** at the factory with detonators **pre-installed** and with the electrical circuit **pre-checked**. It is shipped ready for installation of the HMX Explosive Pellets at the well site in accordance with the procedures in **Section 3.0**. The carrier, void of Explosive Pellets, serves as a "safety tube" for the detonators, with a shipping classification of UN 1.4S.
- 1.3 Titan Severing Tools are rated for 20,000 PSI (137.90 mPa) service at 325° F (163° C) when shipped with RDX SCB detonators or at 400° F (204° C) when shipped with HNS SCB detonators for one hour of exposure (see table below).

2.0 SPECIFICATIONS

¹ Titan Part numbers for Hardware / Pellet Kits	ST OD in. / mm	Severs in. / mm	Min Restriction in. / mm	Exp / kg	Rating T / P	² Number of Pellets	³ DOT Class
SCP-1750STRDX SCP-1750SP22.7	1.775" 45.09	5" DC 127	1.875 47.6	HMX / 1.2 kg	325°F / 20Ksi	55 X 22.7 g (58 in Kit)	1.4S
SCP-1750STHT SCP-1750SP22.7	1.775" 45.09	5" DC 127	1.875 47.6	HMX / 1.2 kg	400°F / 20Ksi	55 X 22.7 g (58 in Kit)	1.4S
SCP-2000STRDX SCP-2000SP22.7	2.030" 51.56	6" DC 152.4	2.125 54.0	HMX / 1.52 kg	325°F / 20Ksi	70 X 22.7 g (74 in Kit)	1.4S
SCP-2000STHT SCP-2000SP22.7	2.030" 51.56	6" DC 152.4	2.125 54.0	HMX / 1.52 kg	400°F / 20Ksi	70 X 22.7 g (74 in Kit)	1.4S

¹ A complete ST assembly requires one each of the Hardware Kit (includes pre-installed detonators) and (HMX) Pellet Kit.

² See **Page 5** for additional details regarding the Number of Pellets required.

³ Severing Tool Mechanical Assembly (Fig. 2), with Detonators installed, is classified as UN 1.4S.



3.0 FIELD ASSEMBLY/ARMING PROCEDURE

- 3.1 This tool, as well as any others containing explosive components, must be used in accordance with the Recommended Practices for Oilfield Safety (API RP 67) and your company's safety policies and procedures. The steps in 3.2 are excerpts from the RP 67 and serve as reminders of basic operational and safety procedures commonly used in the field.
- 3.2 Pre-check electric cable circuit, cable head, CCL and any adapters for continuity and insulation prior to assembly and installation of the ST to the wireline connection. Turn off all communication transmitters and receivers, welders, cathodic protection devices and the electrical generator on the Wireline Unit. Be sure the cable Safety Switch is in SAFE mode. Measure for stray voltages between the Wireline unit to ground (earth), rig to ground and well head to ground, ensuring no hazardous stray voltages are present. Electrically bond Wireline unit, rig and well head together with grounding straps and clamps.
- 3.3 The ST electrical circuit has been 100% pre-checked at the factory. No further testing is required. If necessary, for troubleshooting purposes, electrical tests on the Ecosse FireSet may be conducted using a Digital Safety Multimeter following the procedures outlined below. **MAKE SURE THAT THE TOOL HOUSING IS VOID OF EXPLOSIVE PELLETS BEFORE ANY ELECTRICAL TEST IS PERFORMED.**
 - The Tool Housing serves as the Detonator Safety tube used while arming all perforating devices. Stand clear of the open end of the Tool Housing when making electrical checks or be sure the Bottom Nose and its Retainer Screws are in place.
 - Using a Digital Safety Multimeter set on the 20 megohm scale, take measurements at the Input and Output leads of the Ecosse FireSet.
 - **INPUT LEADS** (or at the Top Sub of the ST) – 4.4/4.6 megohms
 - **OUTPUT LEADS** (or at the wire connections exiting the bottom of the tool, with the EBW Detonator disconnected) – 0.95/1.05 megohms.
- 3.4 **BE SURE SAFETY KEY IS VISIBLE AT THE SEVERING TOOL TO BE CONNECTED.** Install the Shock Sub provided with the ST to the Top Sub of the ST and attach the ST to the wireline tool connection (leave plastic "Titan" thread protector in place when the ST is not attached to other tool connections).
- 3.5 Remove the ST Bottom Nose from the Tool Housing and the Load Rod and position it to the side as shown in Fig. 3. **AVOID EXCESSIVE FORCE ON WIRES.** Use of Channel-Lok pliers may be helpful to remove the Bottom Nose from the Tool Housing.
- 3.6 Remove the Load Rod from the Tool Housing, remove and save the 007 Viton retainer O-Ring from the Load Rod.
- 3.7 Install Pellets onto Load Rod (Fig. 4) until the last one comes to rest within the ½" wide "GREEN" band painted on the rod. If after installing the minimum number of Pellets onto the Load Rod (55 for the 1-3/4" Tool and 70 for the 2" Tool), the "GREEN" band is completely visible and there is a gap between the last Pellet and the end of the "GREEN" band, add one more Pellet. Slip on the 007 Viton retainer O-ring retainer until it butts up against the last Pellet.



- 3.8 Gently insert the Load Rod/Pellet subassembly into the Housing (**Fig. 5**) until it stops (**DO NOT USE EXCESSIVE FORCE**). (The end of the Load Rod will be protruding about 3/8" beyond the end of the Tool Housing).
- 3.9 While feeding excess wire into the off-center bore in the Bottom Nose, guide the Load Rod into the center bore and seat the Bottom Nose into the Tool Housing.
- 3.10 Align the holes in the Bottom Nose and the Tool Housing and install the Cap Screws. The ST is now ready to be run into the well.
- 3.11 To fire the tool, ramp-up to 200-225 VDC+. For additional details and full specifications, please contact the PX-1 FireSet manufacturer:

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4.0 DISARMING / DOWNLOADING AN UNFIRED/MISFIRED ST

- 4.1 Reverse the assembly procedure outlined in steps 3.1 through 3.10 above. If, after a trip into the well, connections prove hard to break, first attempt to bleed off internal pressure by carefully backing off the Pressure Bleed-off Plug (**Fig. 5**) at the bottom of the tool. High pressure liquid (in case of a leak) or high pressure gas (in event of a low order detonation) could be present, therefore wear appropriate PPE (personal protection equipment) and exercise all other safety precautions as specified by your Service Company.
- 4.2 Remove Bottom Nose and position it to the side as shown in **Fig. 3**.
- 4.3 Pull-out Load Rod / Pellet Assembly.
- 4.4 Remove the 007 Viton retainer O Ring. Slide pellets off the Load Rod and place them in their original shipping box for transportation back to an approved storage magazine/facility.

Note:

- a) **DISCONNECTING THE TOP SUB IN THE FIELD SHOULD NEVER BE DONE. IT WILL DAMAGE / DISCONNECT THE ELECTRICAL CIRCUIT.**
- b) In event of an electrical malfunction within the tool, contact the Titan Distribution Center where it was originally acquired for an RMA (Returned Material Authorization). The Explosive Pellets must be removed and placed back into their original shipping container(s) while the ST is temporarily stored.



- c) Unless the operator is experienced in handling malfunctioned explosive tools, it is recommended that, in case of hard to break connections, you contact your field technical representative **IMMEDIATELY** for assistance.
- d) Wiring Diagram (for Reference Only).

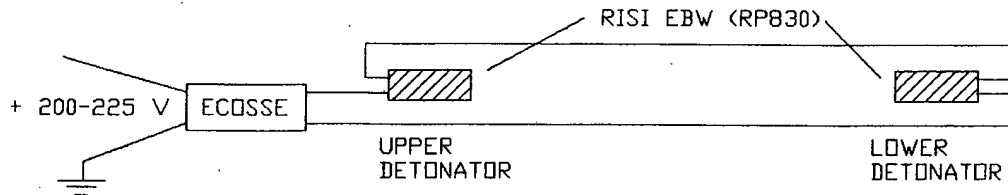


Fig. 1 Wiring Diagram.

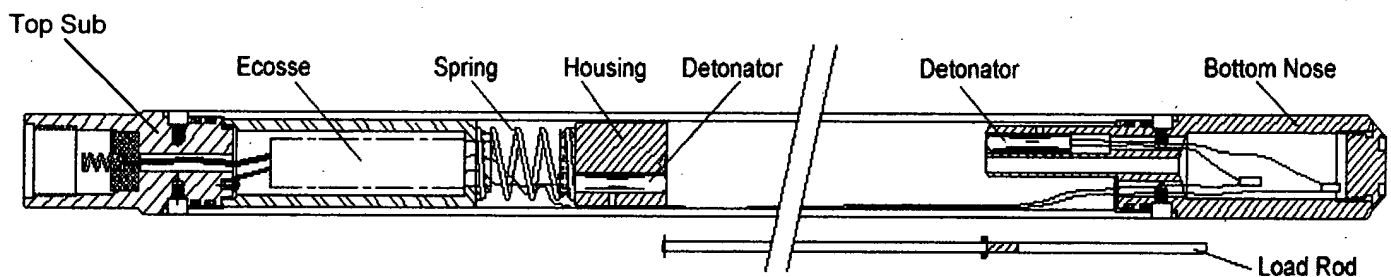


Fig. 2 Severing Tool as received in shipping package.

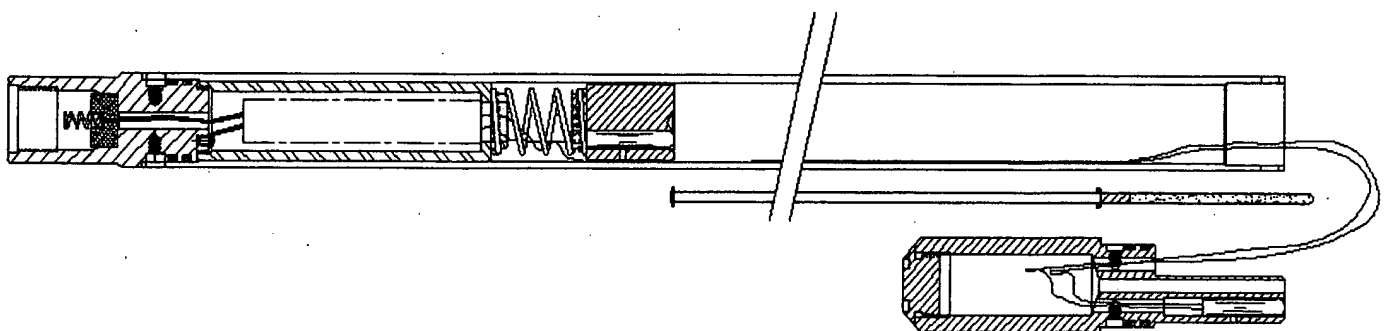


Fig. 3 Remove Bottom Nose and position it alongside Housing as shown.

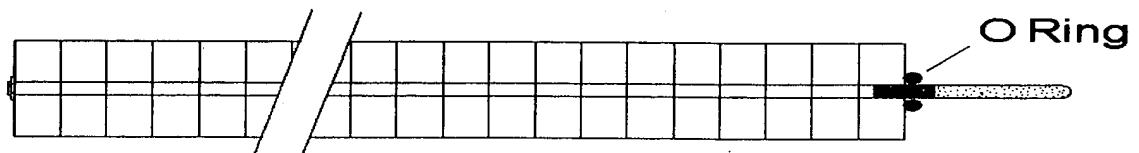


Fig. 4 Remove 007 Viton retainer O-Ring from Load Rod. Install Pellets *** until last one resides in "green" zone. Slip-on the 007 Viton retainer O-Ring against last Pellet to retain it in place on the Load Rod.

*** **Note:** The 1-3/4" tool requires 54 or 55 Pellets (58 Pellets are shipped with each tool) and the 2" tool requires 69 or 70 Pellets (74 Pellets are shipped with each tool). Additional Pellets are provided with each Tool to achieve the correct column length and to provide extra Pellets in the event that one or more are damaged during tool assembly.

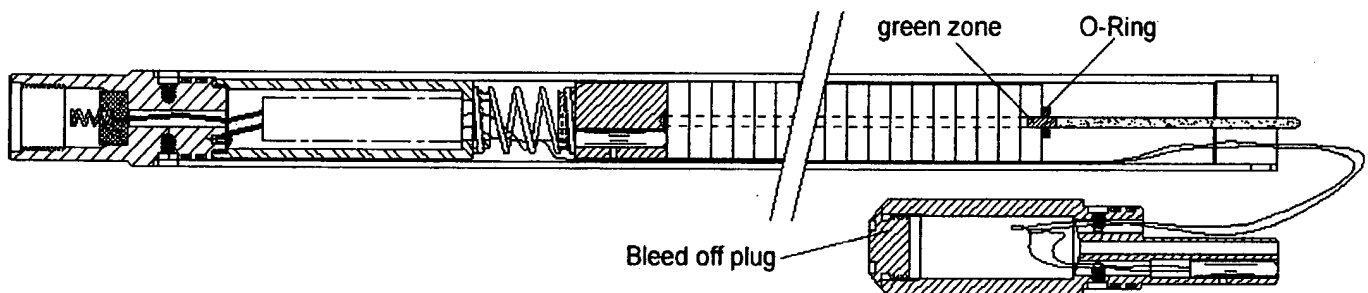


Fig. 5 Slide Load Rod / Pellet Assembly into Housing.

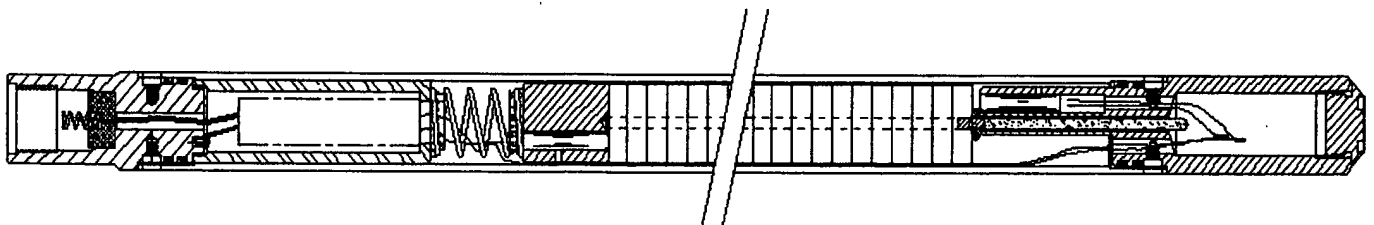
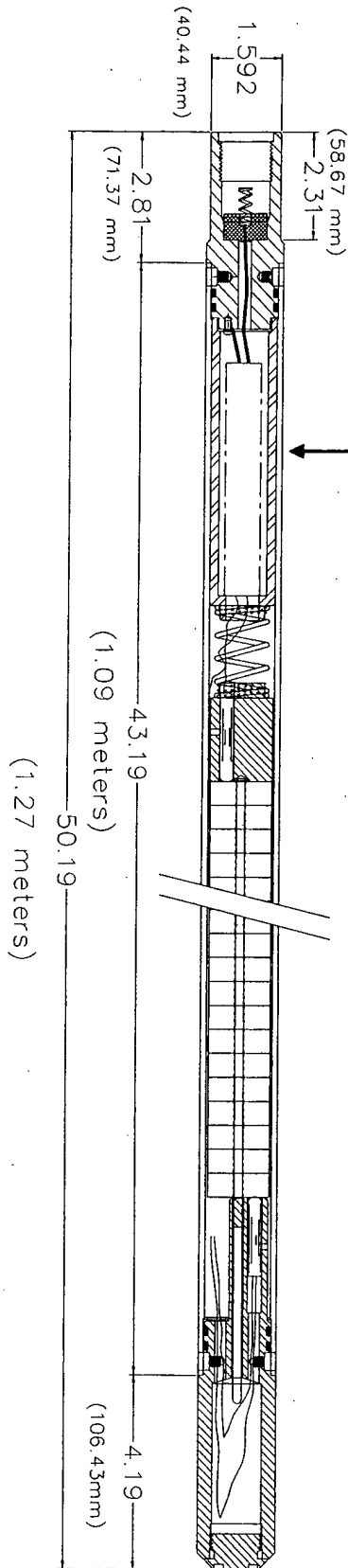


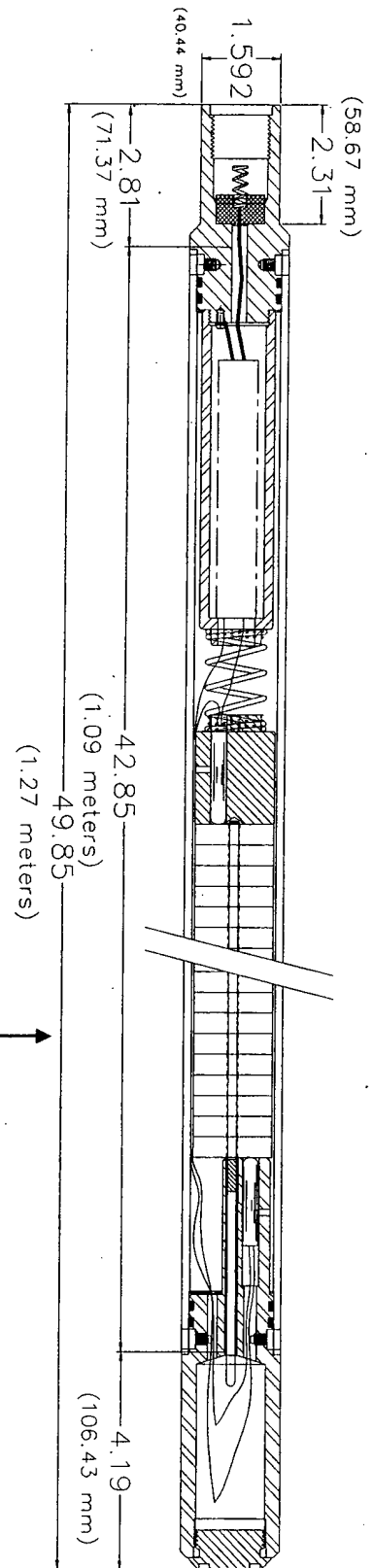
Fig. 6 While aligning the Load Rod into the center bore of the Bottom Nose, guide excess wire into the offset bore and re-insert the Bottom Nose into the Housing. Align holes in the Bottom Nose and the Tool Housing and install Cap Screws.



1-3/4" TOOL
1.775" (45.88 mm) – Max O. D.

RUNNING DIMENSIONS

2" TOOL
2.030" (51.56 mm) - Max O. D.





Ecosse inc

Fireset
Technology

PX-1 Operating Instructions

Revised procedures - do not test-fire before use

CAUTION:- These instructions describe how to use the PX-1 only. They do not replace or override any of the operator's normal safety requirements and procedures. It is the operator's responsibility to ensure that all explosives and associated devices are handled in a safe manner.

WARNING:- The PX-1 generates a high-voltage, high-current pulse that could be dangerous to personnel if the device is misused. Use caution at all times when handling the PX-1, and always use an approved digital multimeter to verify that no significant voltage is present on the output before attaching a detonator. NEVER attach a detonator to the PX-1 without first verifying that any attached power supplies are disabled.

Pre-job check (revised)

The PX-1 fireset is intended for one-time use to initiate EBW or EFI detonators. All firesets are test-fired by Ecosse before being shipped, and to avoid premature failures further test-firing in the field prior to use is not permitted.

Any PX-1 that is test-fired for demonstration or troubleshooting purposes should be expected to fail very quickly, and under no circumstances should it be used on a job afterward. Instructions on how to do test-firings are given overleaf.

Using the PX-1 to fire EBW / EFI detonators

1. Verify that any power supplies attached to the PX-1 or wireline are disabled.
2. Strip 1/3in of insulation from the leg wires of an EBW or EFI detonator, then insert the detonator into a blast shield.
Note: For reference, the Ecosse logo on the side of the PX-1 box is 1/3in wide.
3. Use a digital multimeter to verify that no significant voltage is present on the output capacitor. For a standard meter with a 10M Ω input impedance the display will indicate 1/60th of any voltage present on the capacitor, so a reading of 0.2V would indicate that 12V was present on the capacitor.
4. Depress the orange levers on the output sockets at the end of the PX-1, insert the detonator leg wires into the sockets until they stop, then release the levers.

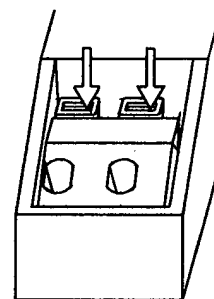


Figure 1

Note: The levers operate more smoothly when pushed on the right side, as shown in Figure 1.

5. Verify that the wires are secure in the sockets, then remove the detonator from the blast shield. Continue with the arming and assembly sequence as required.
6. When ready to fire the detonator, slowly increase the applied voltage (positive DC to the red wire, negative DC to the black/white wire). At about 200-230VDC cablehead voltage the PX-1 will switch on and draw current (160-260mA). Continue increasing the voltage until the PX-1 fires, which should be almost immediately, then power down. Note that at downhole temperatures the PX-1 requires up to 30V more to switch on and fire than it does on the surface.

NOTE: If the power supply being used does not provide a true DC output, see Q1/A1 and Q7/A7 on the other side of this page for power-up characteristics.

If you have any questions or concerns about using the PX-1, please contact Ecosse Inc before using the device.

See over for frequently asked questions.

Rev 01/04

PX1 Fireset Frequently Asked Questions

Rev 01/04

Q1 Is any special equipment required to use the PX-1?

A1 No equipment is required other than a DC power supply to activate the PX-1. However, the power supply needs to supply true DC to power the PX-1 efficiently. Many of the DC supplies used in perforating operations actually deliver unsmoothed full-wave-rectified AC, which is a series of 100-120 voltage "bumps" per second rather than flat DC. Although the PX-1 will work with this input it does so less efficiently, and it will not work above temperatures of about 290-300F with this kind of supply. Also, because of the way most volt meters work it will look as if the PX-1 is switching on at a lower voltage than it actually is (the voltmeter will indicate the average or RMS voltage, while the PX-1 will switch on with the peak voltage).

You should be aware that if you are using the above type of unsmoothed power supply with a very short wireline (7000ft or less), it might be necessary to continue increasing the voltage quickly for a few seconds after the PX-1 switches on before it will fire. It is preferable to avoid this situation by using a true DC power supply to fire the PX-1. Filtering can be added to an unsmoothed shooting supply to provide a true DC output. In its simplest form this can be little more than a capacitor (1000-2000uF) and bleed resistors; if required Ecosse can supply a low-cost plug-in box to meet this need.

Finally, the CCL and other downhole hardware must be capable of handling the cablehead voltage required by the PX-1 (see A4 below), and all electrical connections and insulation must be clean.

Q2 Can the PX-1 be test-fired prior to use?

A2 No. All PX-1s are test-fired by Ecosse prior to shipping, and further testing is unnecessary. Also, experience has shown that test-firing prior to use is more likely to cause an otherwise-good tool to fail than it is to detect a problem.

Q3 Can the PX-1 be test-fired for demonstration or troubleshooting purposes?

A3 Yes, although any tools used for this purpose should be expected to fail very quickly and must not be used afterward on a job. If test-firing is required it should be done into a low-inductance load resistor (solid ceramic type preferred) with a resistance of 100-200Ω, a minimum voltage rating of 6kV, and a minimum power rating of 10W; Ecosse can supply a suitable resistor. The general firing method is the same as described overleaf for downhole operation. At about 200-210VDC input voltage the PX-1 will draw current (160-260mA) and start firing rapidly; *power down as soon as this happens* to avoid overheating and damaging the tool. The power should be ramped down quickly, not toggled off, otherwise damage to the PX-1 might occur. The firing will be indicated by a series of pulsing sounds from the PX-1. Wait 2 minutes after powering down and disconnecting the PX-1 from the power supply, then remove the load resistor.

Q4 Is 260mA @ 210VDC all the surface-supplied power necessary to charge and activate the PX-1?

A4 At a minimum, yes. However, to allow for variations in firesets and a drop in efficiency at higher temperatures you really want a power supply that can provide at least 1A @ 250VDC downhole to give you some margin.

At downhole temperatures the PX-1 requires up to 30V more to switch on and fire than it does on the surface. Also, the coil in most shooting casing collar locators drops current to ground when you apply power to the line. With conventional detonators this usually isn't noticeable, as you will normally be applying only about 30V at the cablehead to fire a 55ohm detonator; if the CCL has a coil resistance of 1000ohm, the coil will draw 30mA versus about 500mA going to the detonator. With the PX-1 and a cablehead voltage of 220V, the PX-1 will be drawing maybe 200mA and the CCL coil will be drawing 220mA. So, your power

supply has to be able to supply current to the CCL coil as well, and the engineer has to be aware that even although the PX-1 won't power up until the cablehead voltage is about 220V, the CCL will be drawing current immediately. Adding it all up, a power supply that can generate 750-1000mA @ 250VDC at the cablehead would be suitable for use with the PX-1. Depending on the type of wireline used and the CCL coil resistance, the voltage required at the surface from the power supply might be as high as 350-400VDC.

Q5 How is the PX-1 connected in the gun?

A5 There are two input wires to the PX-1 - a red wire (positive) and a black/white striped wire (negative). One of these wires is connected to ground and the other wire is connected to the gun through-wire (either wire can be the ground as long as the correct polarity is applied to the other wire when firing the PX-1). The detonator lead wires are plugged into two spring-loaded sockets at the output end of the PX-1.

Q6 What is the firing procedure?

A6 It's the same as firing a conventional detonator, except that you're going for 200-230V at the cablehead rather than 20-30V; basically you hold down the fire button and increase the voltage until the detonator fires. A single sheet with operating instructions for the PX-1 is packed with each device. Also, after firing the voltage should be ramped down rather than switched off instantly, otherwise the rapidly collapsing electromagnetic field around the CCL coil can generate extremely high voltage spikes which can cause insulation problems elsewhere.

Q7 After the PX-1 switches on, how long does it take before the attached EBW/EFI is fired?

A7 With a true DC power supply the PX-1 will switch on and fire the attached detonator almost instantly (less than one second) after the voltage at the input leads reaches 200-230VDC. With an unsmoothed shooting power supply (see Q1/A1) or a long wireline it might be necessary to continue increasing the voltage quickly for a few seconds after the PX-1 switches on before it will fire the detonator.

Q8 Can the PX-1 be fired by toggling the necessary input voltage onto it rather than by ramping it up?

A8 Yes, the PX-1 has been tested successfully with this firing method, with up to 280VDC being switched to the input leads. However, whenever possible the PX-1 should be fired by ramping up the voltage as described earlier.

Q9 Can the PX-1 be fired with a capacitive-dump power supply?

A9 Probably not. The PX-1 has not been tested with this firing method, and it is not a recommended procedure.

Q10 How does the PX-1 work?

A10 The PX-1 uses a capacitor discharge to fire the detonator, triggered by an over-voltage switch. Basically, the fireset has a safety circuit, a high voltage supply, an output capacitor, and a trigger mechanism.

Q11 Can the fireset be used in an exposed gun application?

A11 The PX-1 is not designed to withstand pressure directly, so it must be contained in a protective housing for exposed gun applications. Also, the EBW and EFI detonators currently available are not pressure-rated, so they must be protected as well. If you have a need in this area Ecosse can supply adapter hardware with a 5-6 week lead time (we would need to know your CCL connection looking down and your gun connection looking up). All of the hardware except the detonator housing would be reusable. Ecosse can also supply adapters to use the PX-1 with chemical cutters, setting tools, and cutting/severing tools, down to 1-3/8in OD.